XX. *On the different Structures and Situations of the Solvent Glands in the digestive Organs of Birds, according to the nature of their Food and particular Modes of Life.* *By* Everard Home, *Esq. F. R. S.*

Read June 18, 1812.

THE solvent glands in birds are larger and more distinct from the other parts of the digestive organs than in the class mammalia, which has enabled me to ascertain many circumstances respecting their structure, not to be determined by examining the stomachs of quadrupeds. An account of these is contained in the present paper.

To make the following descriptions more clear and distinct, I shall divide the digestive organs of birds, whether they live on animal or vegetable food, into four parts. The first, is the dilatation of the œsophagus, which forms a reservoir for the food, and which is called the crop. The second, is the part into which the ducts of the solvent glands open, which, I shall call the cardiac cavity. The third, is the cavity embraced by the digastric muscle, or gizzard. The fourth, is the space between the opening of the gizzard, and beginning of the duodenum, which I shall call the pyloric cavity, although in some instances it appears scarcely to deserve that name.

The solvent glands in the whole of the extensive genus falco of LINNÆUS, are cylindrical bodies with very small canals, a villous internal surface, and thick coats, open at one end, closed,

and rounded off at the other; they are placed on the outside of the membrane which lines the cardiac cavity, they lie parallel to one another, and nearly at right angles to the membrane through which they open, the closed end being slightly turned upwards, so as to make the orifice the most depending part. In the golden eagle, (the Falco Chrysaëtos *Linn.*) and the sea eagle, (Falco ossifragus), they form, altogether, a broad compact belt: but in the hawk, (Falco Nisus) this belt is slightly divided into four distinct portions; immediately below these glands the cavity becomes wider, and is inclosed in a digastric muscle of weak power, with a flat tendon on each side. The internal surface of this cavity, which is the gizzard, is soft and vascular.*

In all birds that live on animal food, the solvent glands appear to have a similar structure to that which has been just described, only differing in size and situation. The following are the most material differences which I have met with respecting their situation.

In the Soland goose, (Pelecanus bassanus,) these glands are rather larger than in the eagle, but are placed in the dilated part of the cavity of the gizzard, forming a complete belt of great breadth, consequently are extremely numerous. Their situation and appearance is shewn in the annexed drawing.

In the heron, (Ardea cinerea), the solvent glands are in the same situation as in the Soland goose; they are thinly scattered, and do not form a complete belt, being more numerous on the anterior and posterior surfaces. A ball of

* An engraving of this appearance is given in the Philosophical Transactions for the year 1807, p. 178, pl. xii.

fish bones held together by mucus, was found in the cavity of the gizzard.

In the cormorant, (Pelecanus Carbo), the situation of the solvent glands is the same as in the Soland goose, but they only form two circular spots, one anterior, the other posterior.*

In all these birds, the inner membrane of the gizzard is soft and smooth, but that portion which covers the solvent glands, has a more spongy or villous appearance; and this part is found to secrete a mucus which the other parts do not. This fact appears to be ascertained by the following circumstances: on examining the gizzard of a cormorant that died in consequence of an inflammation in the œsophagus, which had been communicated to the internal membrane of the gizzard, a viscid mucus was found upon the surface covering the solvent glands, and this was not met with in any other part, so that the mucus had been evidently secreted there, and was afterwards coagulated by the liquor of the solvent glands poured upon it, coagulation being the first process which takes place in the act of digestion. This explains the circumstance of ascarides being frequently found enveloped in mucus in this part of the cormorant's gizzard, the mucus on which they feed being secreted in consequence of the irritation they produce on the membrane. In the same manner the flukes in the biliary ducts of the sheep, increase the secretion of the bile by irritating these canals, and then feed on it.

It is generally believed that mucus is secreted by surfaces as well as by glandular structure, but I know of no evidence that

* An engraving of this gizzard is given in the Phil. Trans. for the year 1807, pl. x. p. 178.

the mucus of the stomach comes under this description, except what is now stated.

In birds that live upon fish, and sea insects with crustaceous coverings, as the sea gull, (Larus canus), the gizzard has a horny cuticular lining, and the solvent glands are in the same situation as in the genus falco. In the gizzard were found the scales of small fishes. The appearance of the solvent glands and gizzard are shewn in the annexed engraving.

In those birds that live on land insects, some of whose coverings are soft, others hard, there is a difference in the structure of the digestive organs from what has been described. The solvent glands are placed in a triangular form in the cardiac cavity, which is very large, and immediately under it is a small gizzard with a horny lining. Of this kind is the woodpecker, (Picus minor). A representation of the parts in this bird is annexed.

There is still another variety in the structure of these organs.

In the little auk, the (Alca Alle), the solvent glands are spread over a greater extent of surface than in any other bird that lives on animal food, and the form of the digestive organs is peculiar to itself. The cardiac cavity appears to be a direct continuation of the œsophagus, distinguished from it by the termination of the cuticular lining, and the appearance of the solvent glands. This cavity is continued down with very gradual enlargement below the liver, and is then bent up to the right side, and terminates in a gizzard: when the cavity is laid open, the solvent glands are seen at its upper part, every where surrounding it, but lower down they lie principally on the posterior surface, and where it is bent upwards towards

the right side, they are entirely wanting. The gizzard has a portion of its anterior and posterior surfaces opposite each other, covered with a horny cuticle. These appearances are shewn in the annexed drawing.

This peculiar formation of the digestive organs of the little auk, appears to be fitted for economizing the food; which may be rendered more necessary in a bird, that spends a portion of the year in the frozen regions of the North, where supplies of nourishment must be very precarious.

In birds that live principally on vegetable food, the solvent glands have a different structure, according to the substances the birds are intended to feed upon, and vary a good deal in situation, according to the habits of life. The following are the most remarkable instances of such difference, both with respect to structure and situation.

In the pigeon (Columba domestica), their situation is the same as in the genus falco, but their size is small, the external orifices large, and the coats thin, so that they resemble the glands in the English heron, but having larger cavities.

In the swan, the (Anas Cygnus), the solvent glands appear to be cylinders, as in the genus falco, but are not straight, bending upon one another in a direction obliquely upwards; their internal surface is not villous as in the genus falco, but rather broken and irregular.

In the goose (Anas Anser), the solvent glands have the same situation as in the swan, and resemble them in their external appearance, but when laid open the sides are found to be cellular.

In the common fowl (Phasianus Gallus), these glands are

made up of four small short processes uniting in a middle tube, which opens externally by one orifice.

In the turkey (the Meleagris Gallipavo), the solvent glands consist of four small processes, which diverge from one another in opposite directions.

In a species of parrot, (the Psittacus æstivus), the cardiac cavity is unusually large and long, and the solvent glands are spread over a considerable portion of its surface, the gizzard is very small. Its appearance is represented in the annexed engraving.

In many large birds that only walk and run, their wings being too small to enable them to fly, the digestive organs are formed in many respects differently from those of other birds.

In the cassowary, (Casuarius Emeu), the solvent glands are situated between the crop and gizzard, as in many other birds, but this part is dilated into a large cavity, and separated from the gizzard by an oblique muscular valve; in this cavity the food may be retained for some time, but cannot be triturated there, since the stones and other hard bodies swallowed, will readily force a passage into the gizzard.

I have not had an opportunity of examining the solvent glands in the cassowary, and therefore can say nothing respecting their structure from my own observation.

In the American ostrich, (the Rhea americana), the solvent glands are fewer in number than in other birds. They only occupy a small portion of a circular form, on the posterior side of the cardiac cavity; this however is compensated by the complex structure of which they are composed. To each gland there is one common orifice; when the cavity to which it leads is laid open, three smaller orifices are exposed,

each of which communicates with five or six processes like the fingers of a glove. The structure is similar to that of the solvent glands of the beaver, among quadrupeds.

The cardiac cavity, in which the solvent glands are situated, is dilated to a large size, as in the cassowary, and there is a similar muscular valve separating it from the gizzard. The digastric muscle is weak; but the fibres of which it is composed, and the tendons between the two bellies of the muscle, are beautifully distinct. The appearance of these parts is shewn in the annexed drawing.

In the African ostrich, (the Struthio Camelus,) the solvent glands are unusually numerous, similar in structure to those of the American species; the space in which they are situated is not only dilated into a cavity, but is continued down below the liver, and then bent up upon itself towards the right side, where it terminates in a strong gizzard nearly at the same height as the beginning of the cardiac cavity.

This cardiac cavity of such unusual length and uncommon form is lined with a strong cuticle, except upon the left side where the solvent glands are placed, extending from the top to the bottom, and about four inches in breadth.

The gizzard is unusually small; the grinding surfaces do not admit of being separated to a great distance from one another, and on one side there are two grooves, and two corresponding ridges on the other. Beyond the cavity of the gizzard is an oval aperture with six ridges covered with cuticle to prevent any thing passing out of the gizzard till it is reduced to a small form. These appearances are shewn in the annexed drawing.

In this bird the reverse takes place of what was mentioned to happen in the cassowary and American ostrich, for the stones and other hard bodies swallowed by these birds, must, from their weight, force a way into the gizzard, which is a large cavity adapted to receive them; but here all such substances must remain in the cardiac cavity, both from its being the most depending part, and from the cavity of the gizzard being too small to admit of their entering it.

The cardiac cavity contained stones of various sizes, pieces of iron, and halfpence; but between the grinding surfaces of the gizzard, there were only broken glass beads of different colours, and hard gravel mixed with the food.

In taking a review of the structure of the digestive organs of the cassowary, the American, and African ostrich, whose mode of progressive motion is the same, we find their organs very differently circumstanced with respect to the means of œconomising their food.

The cassowary and American ostrich differ from birds that fly, in having the solvent glands placed in a cavity of unusual size and the muscular structure of the gizzard uncommonly weak; the mode of progressive motion, which is a kind of run, producing so much agitation between the stones and the food, as to render a stronger muscular action unnecessary.

In the cassowary there appear to be no considerations of œconomy in the management of the food in the process of digestion, the solvent glands are less complex than in the ostrich, as is avowed by those who have examined them,* the food has a free passage from the gizzard into the intestines, which are unusually wide and short, so that its passage

* Vide PERRAULT's Comp. Anat. 1676.

through them is very rapid, and is rendered still more so by the stones of a large size employed in the gizzard passing out at the anus. This I learnt from Sir JOSEPH BANKS, who was present at the Cape of Good Hope when one of these birds, to his great astonishment, voided nearly half a bucket full of stones.

In the American ostrich there will be less waste of the food than in the cassowary, as the solvent glands are of a more complex structure, as there is a less ready outlet from the gizzard, and as the intestines are longer and have a variety of convolutions.

In the African ostrich the means of œconomising the food are greater than in other birds; the glands have the same structure as in the American species, are more numerous, are spread over a larger surface, there is a more extensive cavity in which the substances it feeds upon are triturated; and beyond this, a grooved gizzard for the more accurate breaking down of the food. The intestines also are longer and more varied in their course.

All these provisions of nature fit this bird to live in the sandy deserts, of which it is the natural inhabitant; and are not bestowed upon the others that live in countries where food is more abundant.

It is a curious circumstance that the situation of the solvent glands, the shape of the cardiac cavity and position of the gizzard in the alca alle among carnivorous birds is nearly the same as that of the African ostrich among birds that live principally on vegetable food.

EXPLANATION OF THE PLATES.

PLATE XI.

The gizzard of the Soland goose laid open to show the situation and appearance of the solvent glands. The engraving is of the natural size.

PLATE XII.

Shows the form and internal structure of the cardiac cavity and gizzard in the wood-pecker, the sea-gull, and the little auk, all of the natural size.

Fig. 1. The external appearance of the cardiac cavity and gizzard in the wood-pecker.

2. The internal appearance of the cardiac cavity and gizzard of the wood-pecker.

3. The internal appearance of the cardiac cavity and the cavity of the gizzard in the sea-gull.

4. The internal appearance of the cardiac cavity and gizzard of the little auk.

PLATE XIII.

Two views of the digestive organs of the parrot of the natural size.

Fig. 1. An external view of the crop, cardiac cavity, and gizzard.

2. An internal view of the same parts.

PLATE XIV.

An external view of the cardiac cavity and gizzard of the American ostrich, one-fourth of the natural size.

PLATE XV.

An internal view of the cardiac cavity and gizzard of the American ostrich, on the same scale as the last plate.

The orifices of the solvent glands are very conspicuous in the cardiac cavity.

PLATE XVI.

An external view of the cardiac cavity and gizzard of the African ostrich, one-sixth of the natural size.

PLATE XVII.

Represents the internal view of the African ostrich's gizzard, and also a series of solvent glands belonging to different birds.

Fig. 1. The internal surface of the cardiac cavity and gizzard of the African ostrich. On the same scale as in the last plate.

Fig. 2. A series of solvent glands to show the different appearances which they put on.

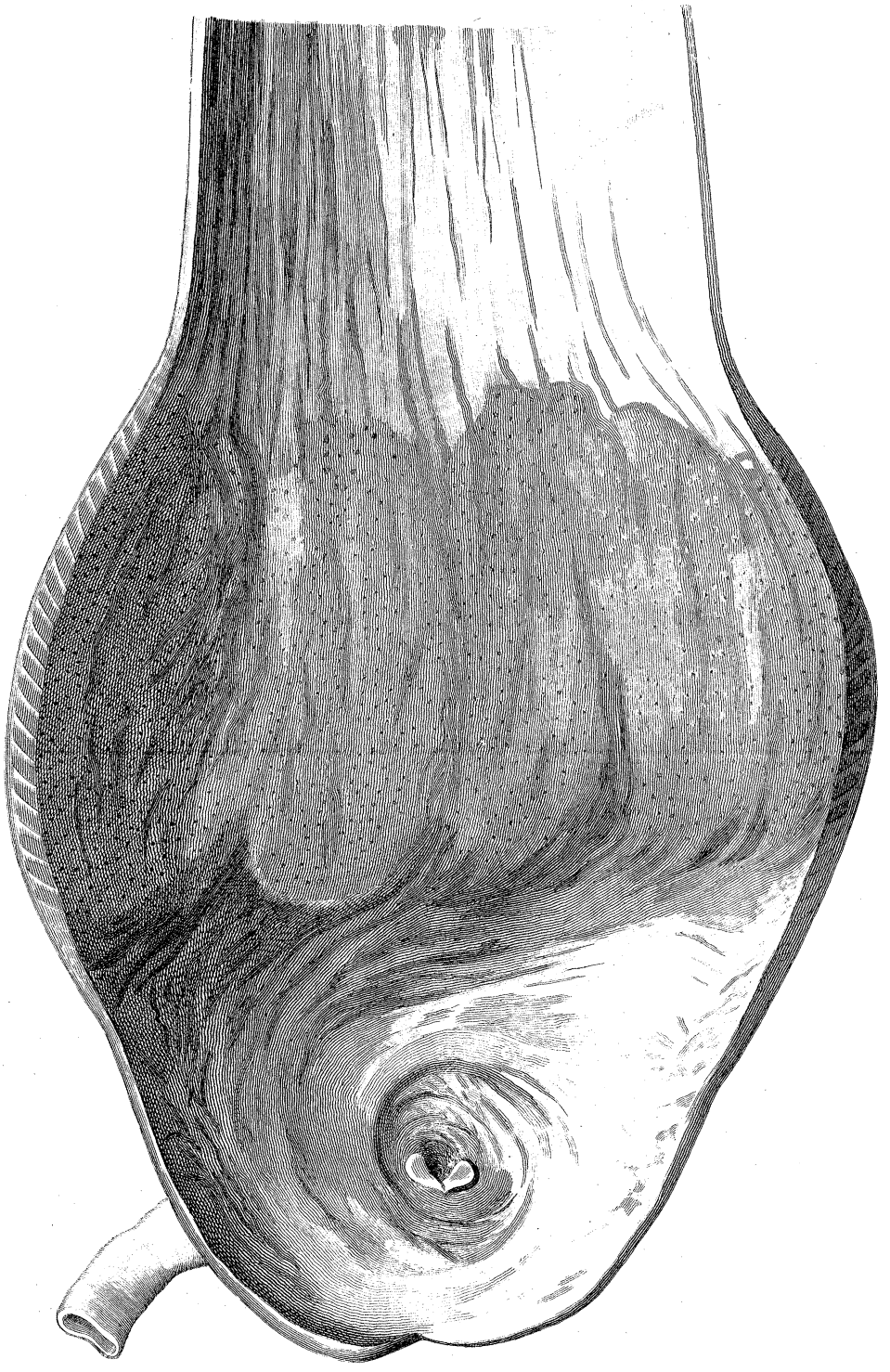

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Fig. 1.

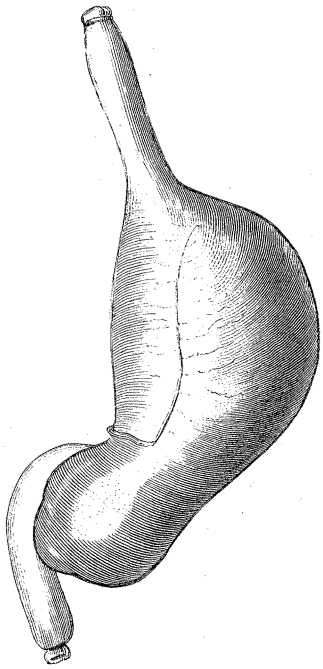


Fig. 2.

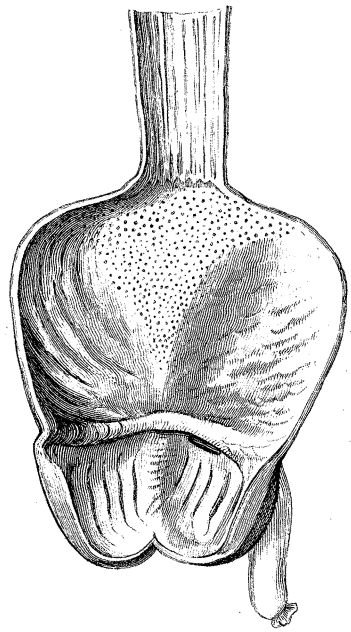
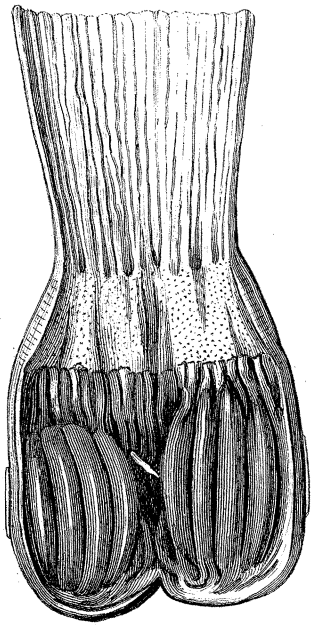


Fig. 3.



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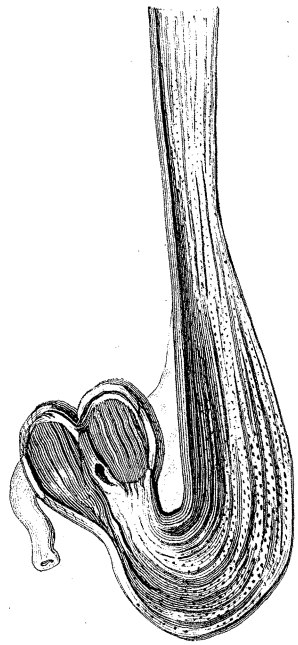

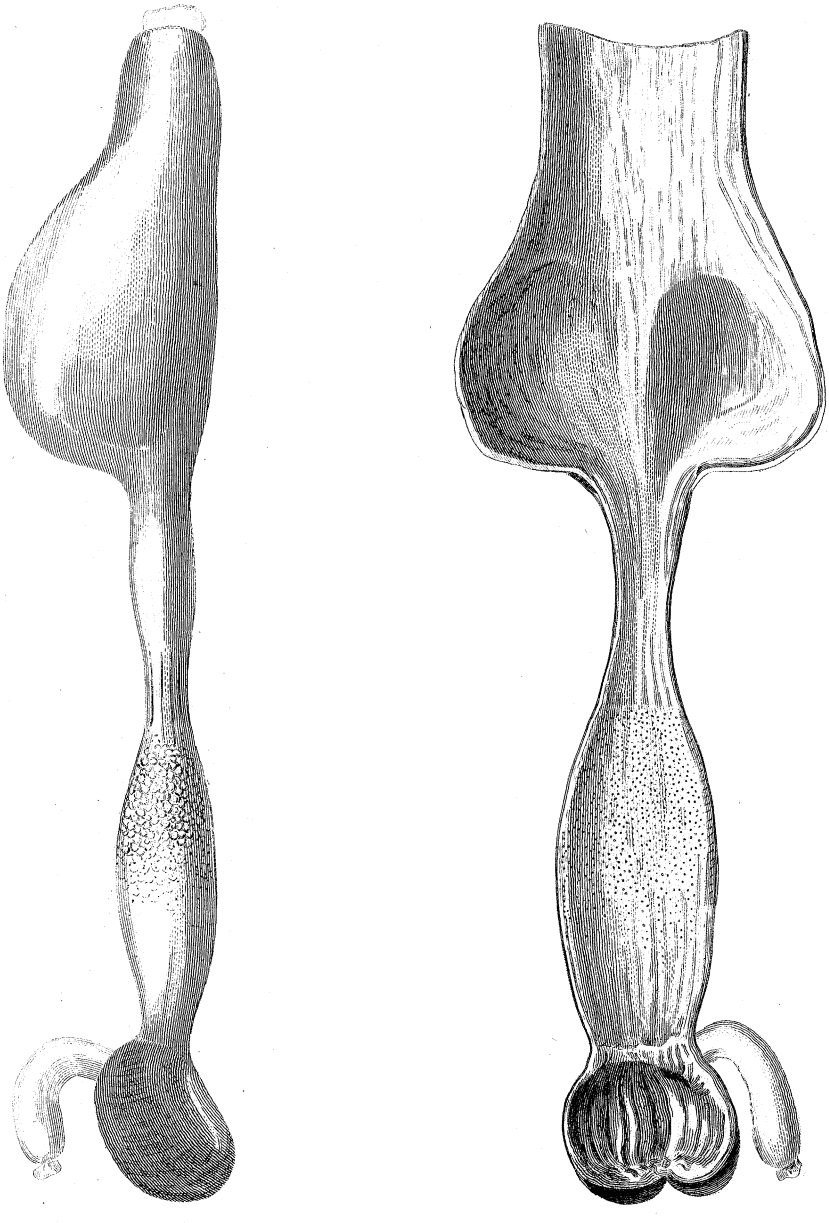

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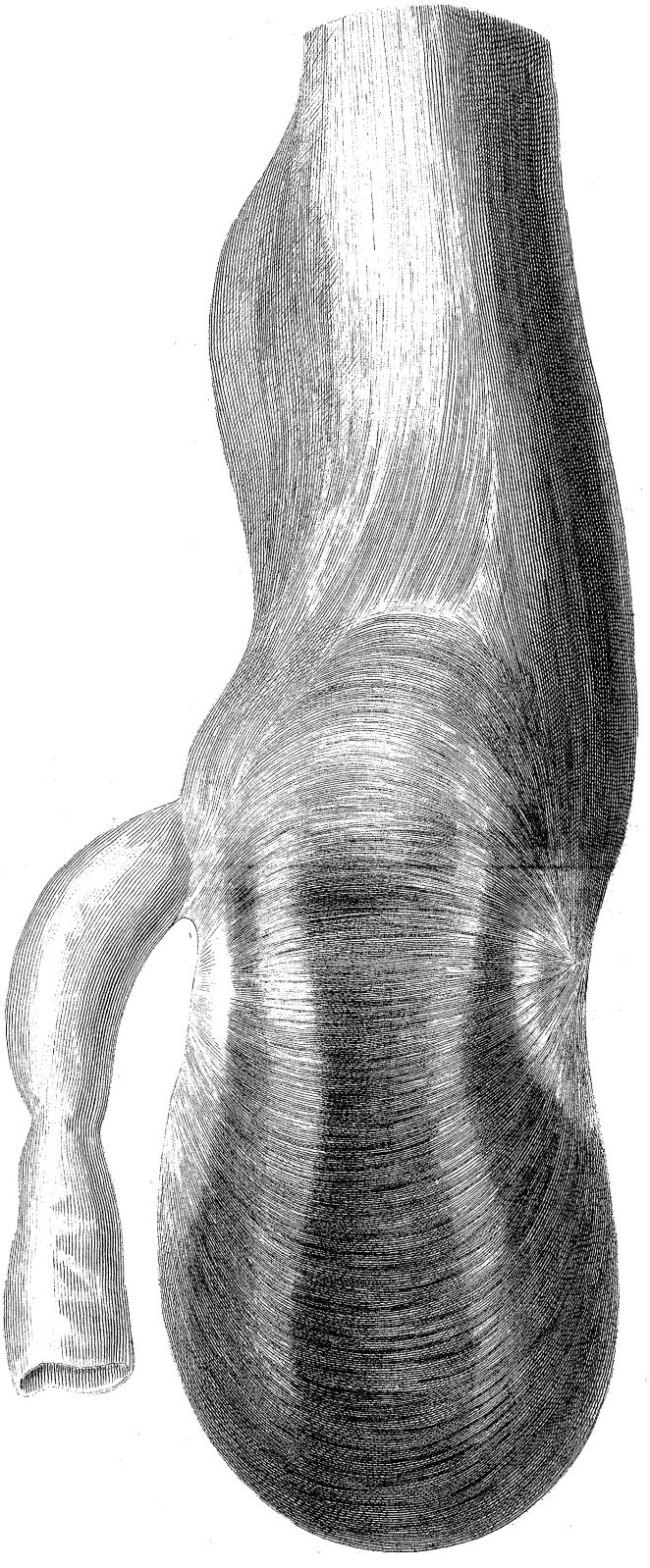

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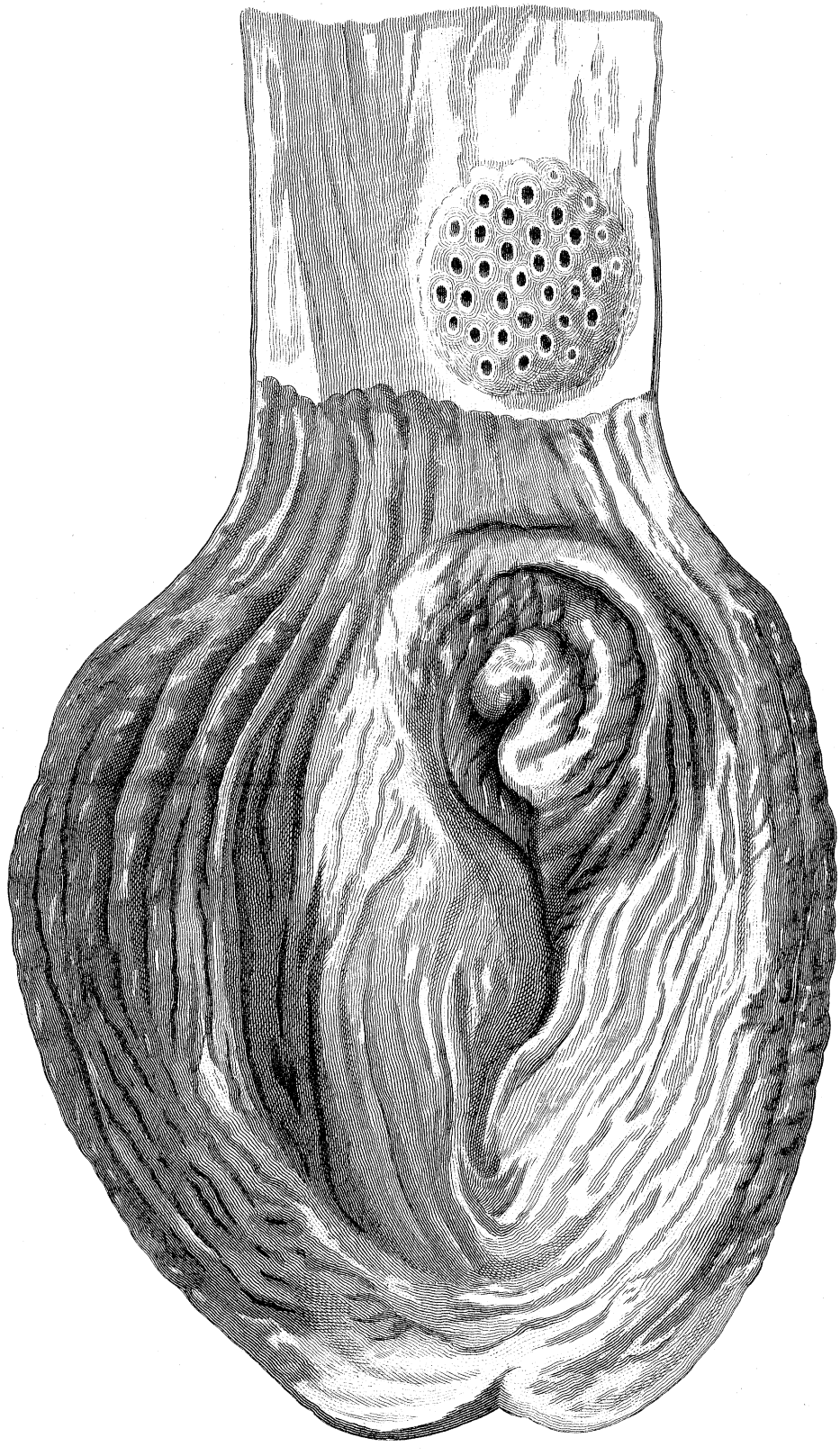

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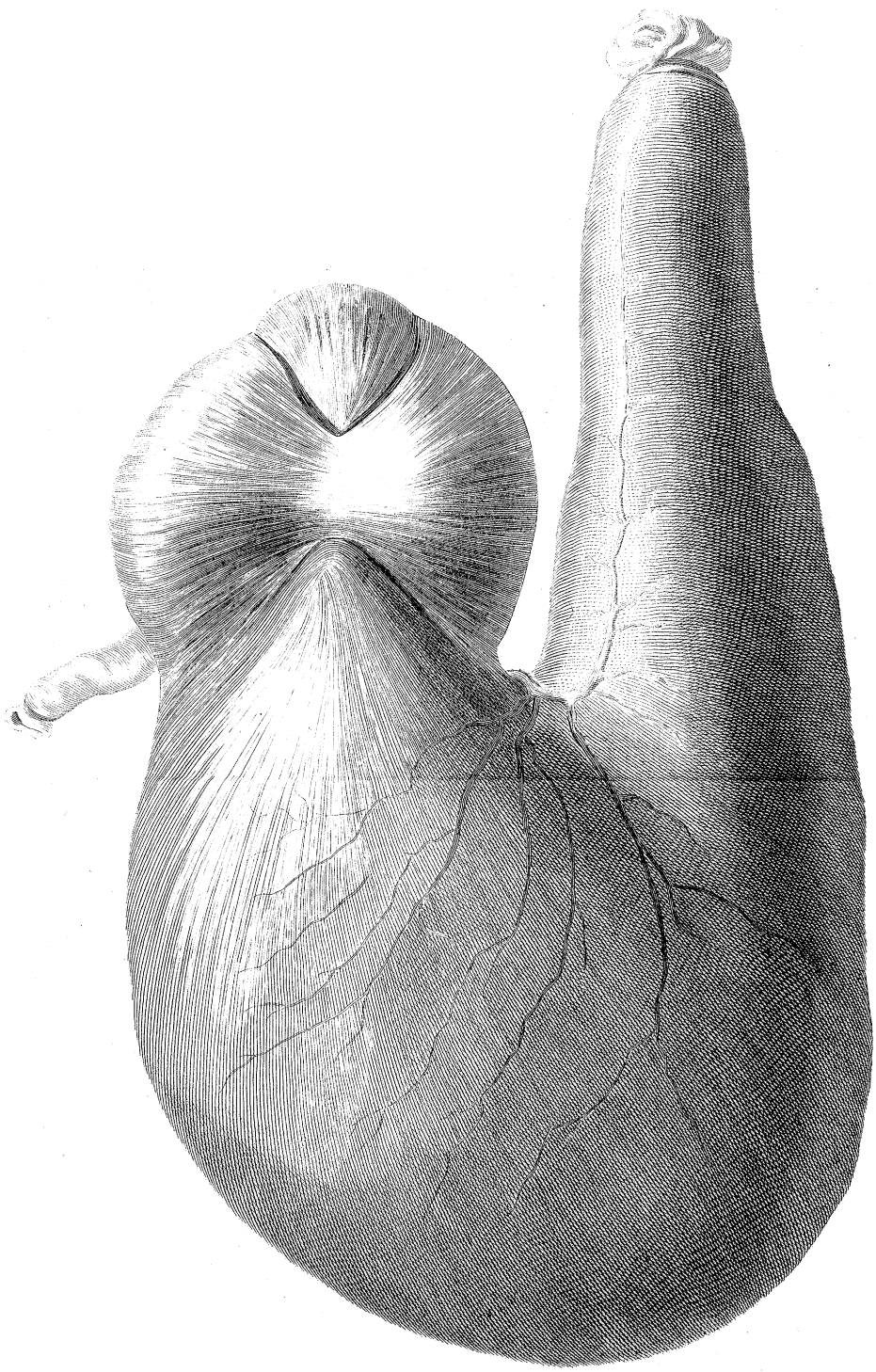

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Solvent Glands.

For Animal Food.	*For Vegetable Food.*
Eagle	*Pigeon*
Soland Goose	*Swan*
Sea Gull	*Goose*
	Fowl
	Turkey
	American Ostrich
	African Ostrich